
WEATHER FACILITY REQUIREMENTS

Introduction

This chapter addresses requirements for facilities that provide aviation weather data and a conceptual means to acquire and disseminate such information on a real-time basis to pilots and other users. The former objective is accomplished through the strategic placement of automated weather observing system (AWOS) units and the latter seeks to define a network capability which can utilize existing and planned State data and telecommunications systems. Appendices B, C, D and E provide the results of aviation and State agency surveys that addressed the need and use of weather data. Appendix F provides background information on automated weather facilities.

AWOS Requirements

For aviation purposes, the AWOS serves to provide real-time weather data at an airport to support the utilization of instrument approach procedures, eliminate the incorporation of remote altimetry penalties. Depending on the nature of the flight activity (commercial or pleasure), the AWOS permits the legal operation of the aircraft. For example, the AWOS-2 provides the capability (visibility) of determining whether a specific airport is actually above or below the minimums established for the specified approach for aircraft operating under Federal Aviation Regulation (FAR) Parts 121 or 135. The use of an AWOS-2 as a sole weather observation source by FAR Part 121 or 135 certificate holders is approved on a case-by-case basis. The determination is made by the AFAA and is dependent on how the operator's procedures for a particular airport incorporate the use of the AWOS-2 data. The FAA may approve operational limitations dependent on the circumstances of each case. The AWOS-3 provides further data in terms of ceiling height which information is required if the airport is identified as an alternate in the pilot's IFR flight plan. An AWOS-3 is approved for FAR Part 121 and 135 flight operations without restriction.

The installation of AWOS units at airports across a large geographical area provides an additional benefit beyond the terminal environment in that pilots are able to receive real-time weather data information along their route of flight. Safety is the primary advantage and the secondary benefits relate to enhanced utilization of the airport system and increased operating capacity. Knowledge of weather conditions on a real-time basis can help pilots determine:

1. If flights can be made safely before leaving the ground.
2. If continued flight toward the intended destination is advisable.
3. If diversion to the alternate airport should be initiated.

A distribution of AWOS units, complementing a planned deployment of federally-installed and operated facilities, also serves to provide real-time weather information to users outside of aviation.

Given the large number of airports in the Arizona system, development of a means to identify the most appropriate automated weather observing capability in promoting and establishing a real-time aviation weather data information network was necessary. The methodology employed is built upon the following factors as described in the sections below.

AWOS Level Determination

When AWOS technology was re-introduced to the aviation community in the early 1980's for application at those airports not anticipated to receive a federal installation, the cost differential between each level of AWOS was significant. An AWOS-1 could be installed for about \$65,000 while and AWOS-3 was nearly double that amount. Consequently, care was exercised in selecting the most appropriate level AWOS for an airport. Since then and as a result of increased competition in the AWOS market, the installed cost of an AWOS-3 is about \$75,000 in comparison to a \$40,000 cost for an AWOS-1. The reduction in the cost between the AWOS-1 and AWOS-3 has narrowed considerably; an installed AWOS-2 is estimated at \$50,000. Most vendors have established the AWOS-3 as their primary unit of sale and economized in its manufacturing process. Therefore, the need to focus on which level of AWOS capability is required has now become less of an issue. The estimated annual maintenance and operating costs of an AWOS-1 and AWOS-3 is about \$3,000 and \$4,000, respectively. Thus, the continuing financial operating obligation of either unit is within a narrow range. Consequently, the AWOS-3 has become the standard level at nearly all airports today.

The industry's "standardization" of the AWOS-3 is also substantiated by consideration of the following factors:

1. The AWOS-3 is approved for FAR Parts 121 and 135 flight operations without restriction. Because these flight operations are not airport-specific, the availability of the AWOS-3 at an airport does not present an operational impediment.
2. Industry trends are such that the AWOS data has been increasingly transmitted to the federal weather data networks. The primary point of data entry for AWOS reports is through NADIN and the FAA and NWS will only accept AWOS-3 data.
3. Technological advances in AWOS equipment are expected in the future. FAA-certified vendors have provided the option to add three sensors to its version of the AWOS-3 configuration. These sensors include a thunderstorm detector to provide advanced warning of such activity within 30 miles of the AWOS site; a present weather sensor to provide precipitation identification including rain, snow, fog and smoke; and a freezing rain sensor. These additional sensors have been approved for use by the FAA and nearly constitute its definition of an AWOS-4. The addition of a runway surface sensor would complete the FAA-defined components constituting an AWOS-4. This sensor would identify whether the runway surface is wet or the potential for icing conditions exist.

The sections below present the basis for identifying AWOS-3 requirements at the system airports throughout Arizona.

Each system airport within Arizona was evaluated with respect to its need for an AWOS-3 based on the following criteria:

1. The airport, whether existing or planned, is included in the Arizona system of public-use facilities.
2. Those airports with an existing or planned federal ASOS or AWOS-3 are expected to maintain or receive the designated facilities. ASOS units have been installed in lots as authorized by the NWS in concert with the FAA. Budget constraints and other factors have influenced the staged implementation program and those ASOS units assigned to Lots 7a and 7b are not anticipated to be purchased by the NWS/FAA. The resulting federal deployment of ASOS and AWOS-3 units, together with those non-federal AWOS-3 facilities presently in operation, may be collectively referred to as the existing or backbone system.

3. Each system airport served with an existing or future instrument approach should be equipped with an AWOS-3 provided it meets the benefit/cost criterion described below.
4. Activity levels projected at each AWOS-3 candidate system airport should be sufficient to yield a benefit/cost ratio of 1.0 or greater, thus justifying the installation and continued maintenance of the unit. In other words, the value of the benefits exceed those associated with the costs to provide the facility. The higher the resulting benefit/cost ratio, the greater the justification for the unit.

The benefits to users of an AWOS facility center on issues related to safety and operational efficiency. The latter concerns the potential reduction in flight disruptions; safety benefits consider the accident potential associated with a particular weather phenomenon such as wind, temperature, dew point, ceiling and visibility. Benefit values determined by the FAA in its "Establishment and Discontinuance Criteria for Automated Weather Observing Systems (AWOS)" and the associated evaluation methodology were used as guidelines in determining the benefit of each potential AWOS-3 unit. The total benefit value varies dependent on the number of general aviation local and itinerant aircraft operations. The FAA benefit values were adjusted for inflation rates since they were first determined. The resultant current dollar benefit for each local aircraft operation is about \$0.25 and \$2.25 per itinerant aircraft operation. The benefit values are conservative in that they exclude those benefits to nonaviation users.

Because the AWOS-3 is assigned a 10-year useful life, airports should be evaluated for their benefit/cost in each of the two, 10-year periods covered in this study. In this fashion, airports that do not qualify based on their activity level forecasts for years 1 through 10 may yield a justifiable ratio as a result of their expected aviation activity between years 11 and 20 of the forecast horizon.

5. The resulting statewide distribution of AWOS and ASOS units should be within a 25-nautical mile radial coverage from any system airport with an instrument approach procedure. This will permit pilots to file an AWOS-3 airport as an IFR alternate to their intended destination. The 25-nautical mile radius is representative of the typical broadcast range of an ASOS and AWOS-3 unit and the AWOS report is for conditions at the airport proper.

6. The resulting statewide distribution of AWOS and ASOS units should be also capable of monitoring the movement of weather, particularly along common frontal passage routes. Coverage requirements were based on a 30-knot frontal passage speed and a 90-minute travel time between these units, thus representing a distance of 45 nautical miles.

Table 7-1 presents a listing of those airports comprising the AWOS/ASOS Backbone System. There are a total of 25 airports. Figure 7-1 illustrates the area coverage afforded by the Backbone System.

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Table 7-1
AWOS / ASOS BACKBONE SYSTEM

<u>Airport</u>	<u>Type Unit</u>
Avra Valley	AWOS-3
Bisbee Douglas International	ASOS
Casa Grande Municipal	AWOS-3 ¹
Chandler Municipal	AWOS-3
Colorado City Municipal	AWOS-3
Ernest A. Love Field	ASOS
Flagstaff - Pulliam	ASOS
Grand Canyon National Park	ASOS
Kingman	ASOS
Lake Havasu City Municipal	AWOS-3
Libby AAF / Sierra Vista	AWOS-3
Nogales International	ASOS
Page Municipal	ASOS
Phoenix - Deer Valley	ASOS
Phoenix - Sky Harbor International	ASOS
Ryan Airfield	AWOS-3
Safford Regional	ASOS
Scottsdale	ASOS
Sedona	AWOS-3
St. Johns Industrial Airpark	ASOS
Taylor Municipal	AWOS-3
Tucson International	ASOS
Window Rock	ASOS
Winslow Municipal	ASOS
Yuma International	ASOS

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See Appendix A for acronym definitions.

Note: 1. FAA Facilities and Equipment Program unit.

Sources: Airport / Facility Directory, 1997.

FAA records, 1997.

Figure 7-1
AWOS / ASOS BACKBONE SYSTEM

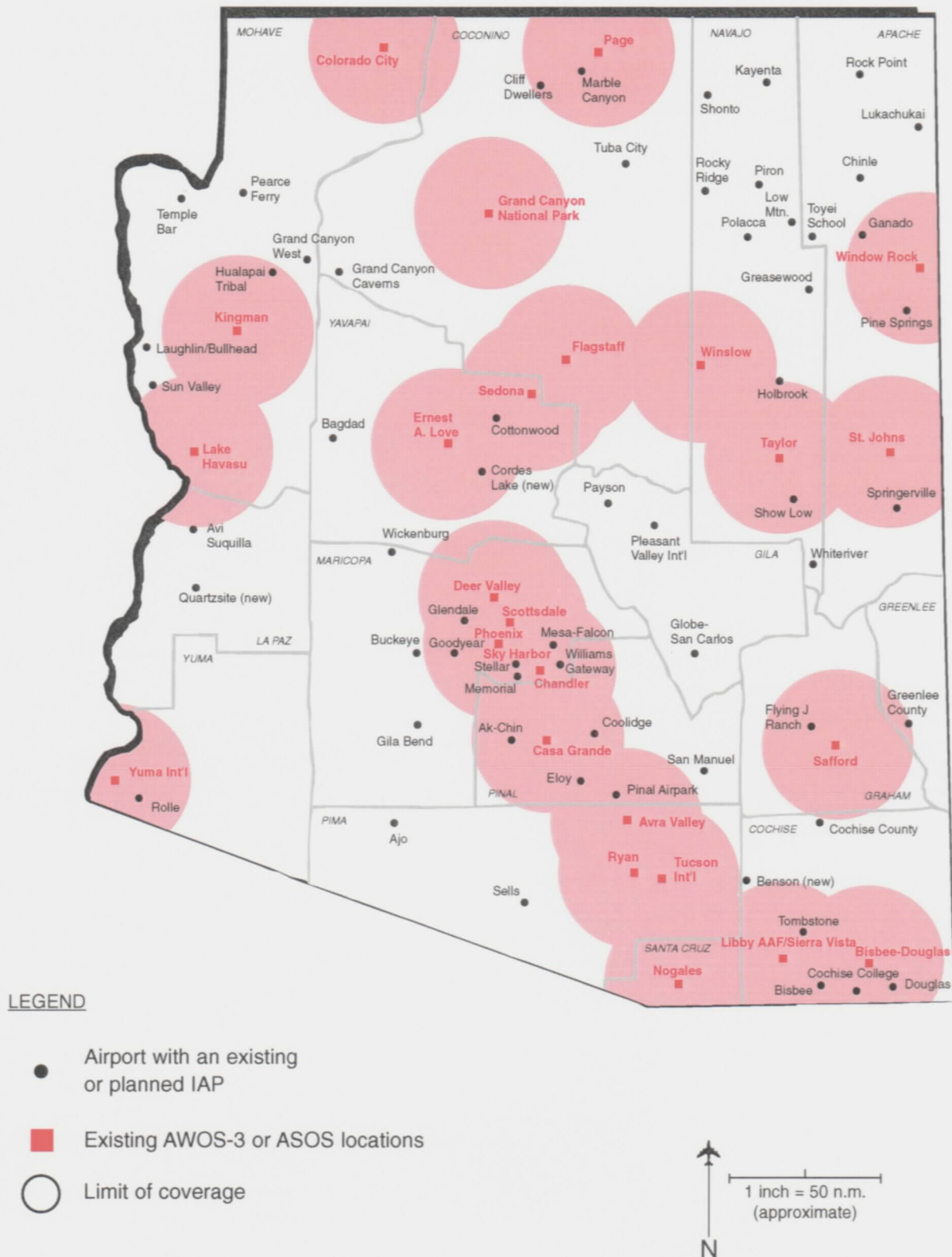


Table 7-2 was generated to list those airports that satisfy Criterion 3 (existing or planned instrument approach) and Criterion 4 (benefit/cost ratio equal to greater than 1.0) and that are not included in Table 7-1. There are 20 such airports and their contribution to area coverage is presented in Figure 7-2 representing AWOS Scenario 1.

Examination of Figure 7-2 indicates that there are gaps in area coverage to satisfy Criterion 5. This criterion suggests that all airports with an instrument approach procedure be located within a 25-n.m. range of an AWOS-3 or ASOS unit. These deficiencies can be partially eliminated through the strategic positioning of AWOS-3 units at the 10 airports listed below. The contribution to area coverage afforded by these 10 additional units is illustrated in Figure 7-3 as AWOS Scenario 2.

Ajo Municipal	Kayenta
Chinle	Polacca
Cochise County	Sells
Globe-San Carlos Regional	Tempe Bar
Grand Canyon Caverns	Tuba City

As a result of adding these 10 AWOS-3 units, 7 airports continue to lie beyond the 25-nautical mile radius of airports located in their general regions with an ASOS or AWOS-3. These include:

Benson Municipal (New)	Lukachukai
Greasewood (Closed)	Rock Point
Greenlee County	San Manuel
Holbrook Municipal	

However, there are ASOS and AWOS-3 sites located within 30 to 35 nautical miles of these airports. This is considered to yield an acceptable satisfaction of Criterion 5.

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Table 7-2
AWOS SCENARIO 1

<u>Airport¹</u>	<u>Benefit / Cost Ratio for Years²</u>	
	<u>1 - 11</u>	<u>12 - 20</u>
AWOS / ASOS Backbone System And:		
Avi Suquilla	3.14	3.57
Bagdad	4.23	6.58
Buckeye Municipal	5.34	11.33
Cochise College	6.48	6.48
Coolidge Municipal	1.08	1.29
Cottonwood Municipal	1.60	3.04
Eloy Municipal	2.98	3.34
Gila Bend Municipal	2.02	2.28
Glendale Municipal	16.56	26.69
Laughlin / Bullhead International	6.67	7.73
Memorial Airfield	1.10	3.65
Mesa - Falcon Field	25.99	27.16
Payson	2.53	2.84
Phoenix - Goodyear	29.46	35.01
Pinal Airpark	0.84	1.73
Show Low Municipal	2.50	2.53
Springerville - Babbit Field	1.18	1.20
Stellar Airpark	6.52	6.68
Wickenburg Municipal	2.21	3.62
Williams Gateway	6.48	12.16

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See Appendix A for acronym definitions.

Notes: 1. Each airport listed has or is planned to have an IAP capability.

2. Benefit / cost ratio greater than or equal to 1.00 indicates an AWOS
is justified based on values of benefit and cost.

Benefit / cost ratio less than 1.00 indicates an AWOS is not justified.

Figure 7-2
AWOS SCENARIO 1
 (BACKBONE AND AWOS-3'S WITH BENEFIT / COST ≥ 1.0)

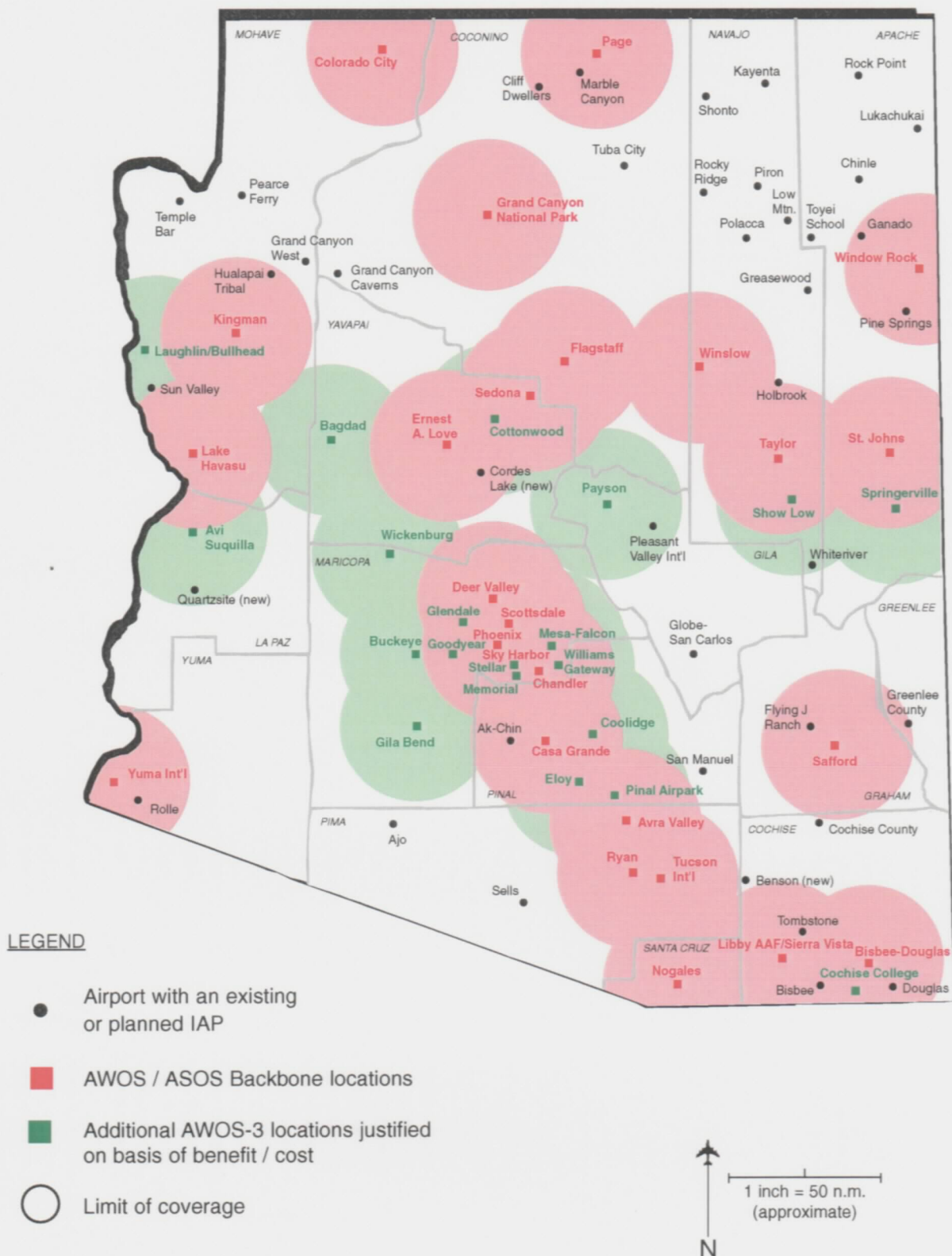
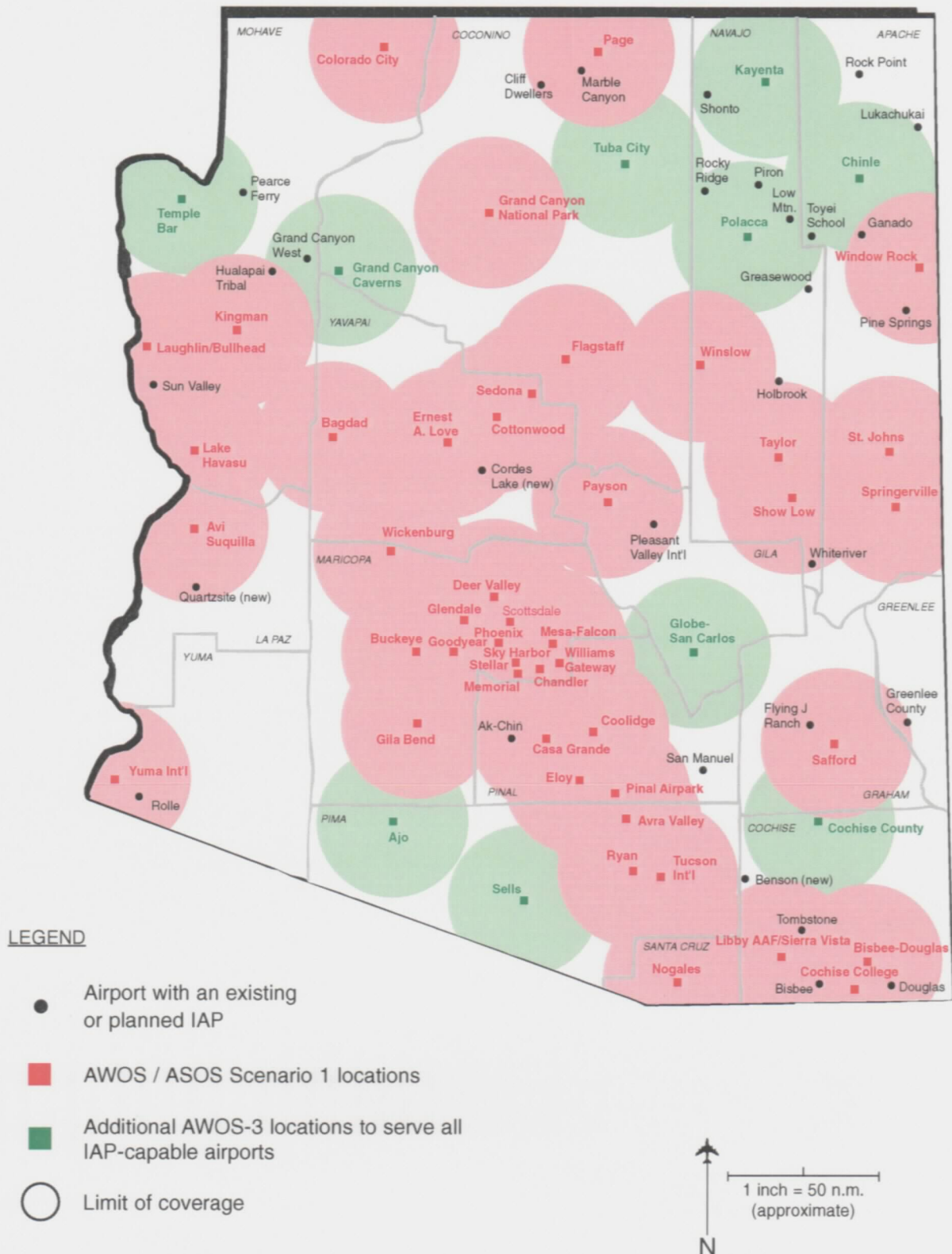


Figure 7-3
AWOS SCENARIO 2
 (AWOS SCENARIO 1 AND STRATEGIC AWOS-3 LOCATIONS AT IAP AIRPORTS)



The resulting distribution of the 55 ASOS/AWOS-3 sites was evaluated with respect to Criterion 6 – coverage of weather frontal movement. In order to meet this objective, a total of three additional AWOS-3 units are required as follows:

- Dateland, a closed airport midway between Gila Bend Municipal and Yuma International and within the unrestricted airspace corridor between these airports.
- H.A. Clark Memorial Field
- Tuweep

The addition of the above three AWOS units to those preceding form AWOS Scenario 3 which is illustrated as Figure 7-4. Some areas of non-coverage of weather movement remain, however, there are no suitable sites to fill in these gaps. The maximum distance between aviation weather facility sites is about 100 nautical miles.

AWOS Scenario 3 was then evaluated to determine if AWOS-3 sites in proximity to one another substantially benefit the system. For example, there is extensive overlap of coverage in the Phoenix region where abrupt changes in topography is not a factor and near homogeneous weather conditions exist. Other regions of overlap include the corridor from Casa Grande southeast to Douglas, and in southern Apache and Navajo counties. Where appropriate, the installation of an AWOS-A unit would satisfy an aviation requirement and avoid an assessment of a remote altimetry penalty. Weather reports from adjacent ASOS and AWOS-3 units would satisfy the aviation weather needs. Exceptions to this rationale extend to those airports expected to have an instrument approach capability of ½-mile visibility. On this basis, AWOS-A units would provide a satisfactory operational capability at the following five airports:

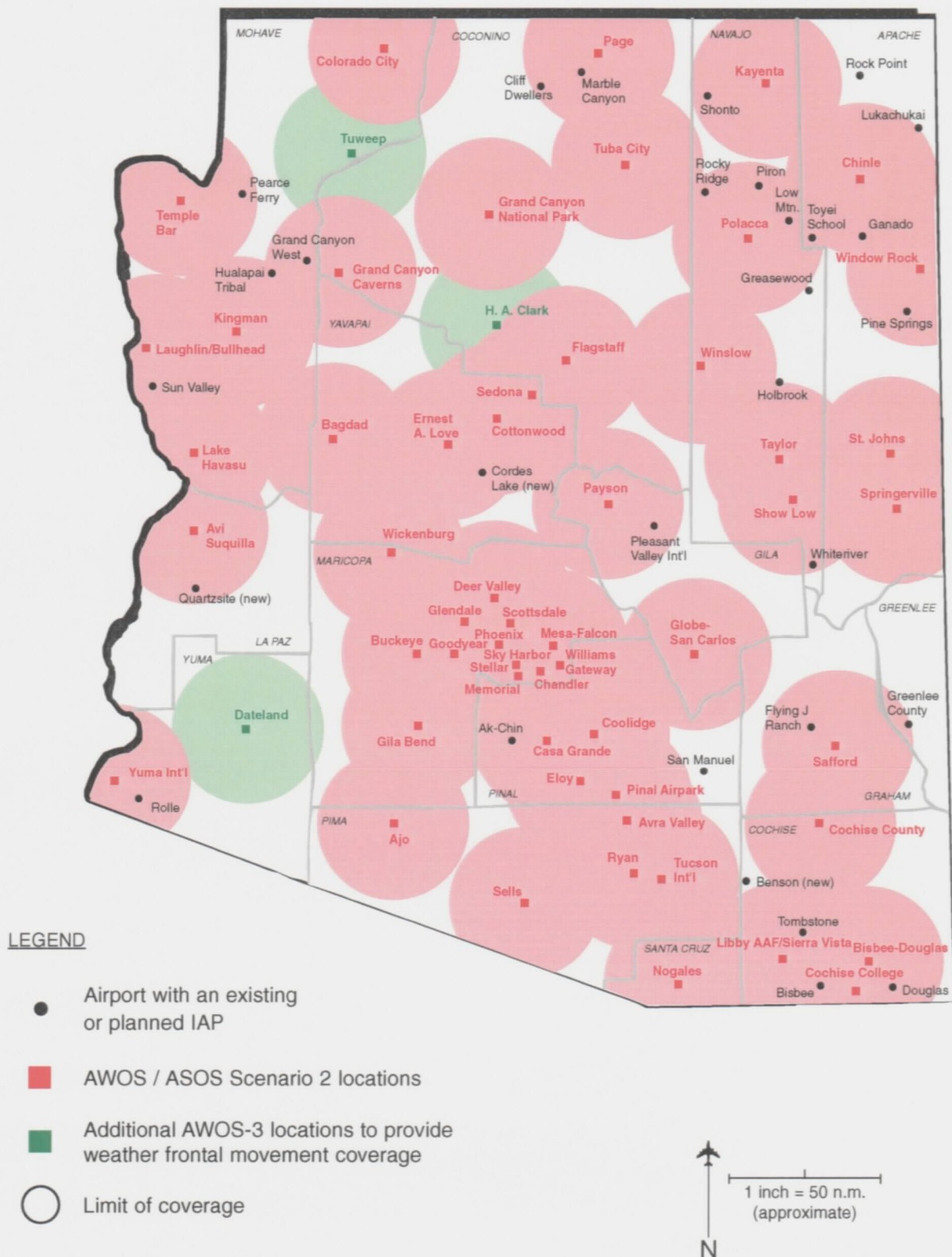
Coolidge Municipal
Glendale Municipal
Memorial Airfield

Pinal Airpark
Stellar Airpark

Intervening terrain in southern Apache and Navajo counties precludes the ability to substitute an AWOS-A for AWOS-3 facilities.

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Figure 7-4
AWOS SCENARIO 3
 (AWOS SCENARIO 2 AND AWOS-3'S FOR INCREASED COVERAGE)



The AWOS Scenario 3 distribution was further evaluated with respect to a requirement for an AWOS-A at those airports with a recommended GPS approach but not otherwise selected to receive an AWOS-3 or AWOS-A unit. The purpose of the AWOS-A at these airports is to eliminate the assessment of a remote altimetry penalty for the potential approach. There are 30 airports that fall under this situation. It was considered appropriate that an investment in an AWOS-A should be made at those airports with annual activity levels, at any year of the forecast horizon, that could economically justify the annual maintenance cost of the facility. This threshold value is 2,000 annual aircraft operations. Consequently, there are eight airports that qualify to receive an AWOS-A. These include:

Bisbee Municipal	Greenlee County
Cordes Lake (New)	Marble Canyon
Douglas Municipal	Quartzsite (New)
Grand Canyon West	San Manuel

The resulting Final AWOS Requirements for the Arizona system of airports and aviation requirements is summarized in Table 7-3 and illustrated in Figure 7-5. A total of 66 ASOS/AWOS units are required representing a need for 41 new facilities (28 AWOS-3 and 13 AWOS-A), as follows. Of these, a total of 25 exist as the Backbone System.

Existing Facilities	Number of Units
Backbone AWOS/ASOS units	25
Future Facilities	
AWOS-3 units for airports with an IAP and an AWOS-3 benefit/cost ratio of 1.0 or greater and all airports with ½-mile visibility minimum	15
AWOS-3 units to meet 25-nautical mile radius coverage for alternate airport filing and en route diversion purposes	10
AWOS-3 units for weather movement coverage	3
AWOS-A units to avoid assessment of remote altimetry penalties	<u>13</u>
Total	66

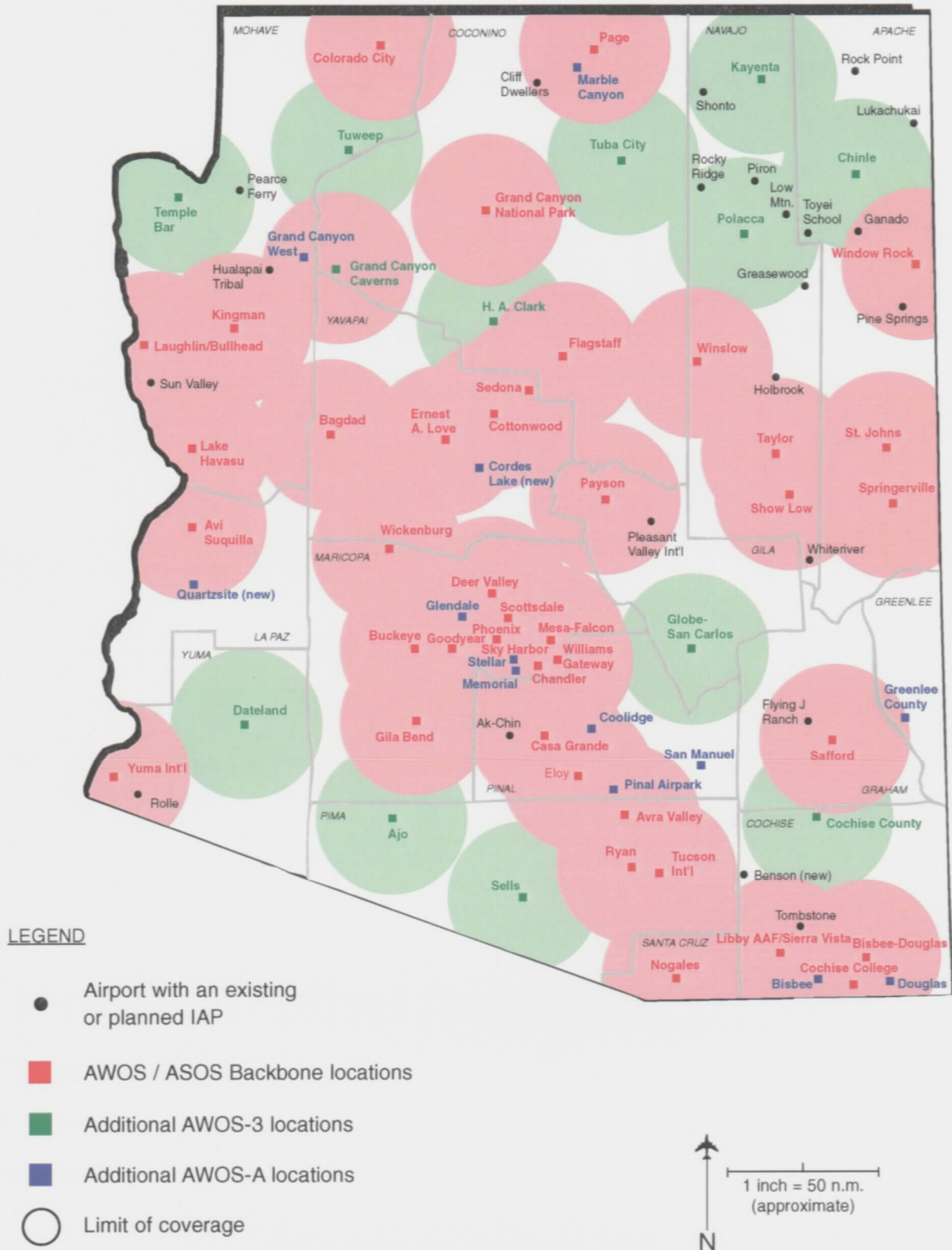
Table 7-3
FINAL AWOS REQUIREMENTS

<u>Airport</u>	<u>Type Unit</u>	<u>Airport</u>	<u>Type Unit</u>
AWOS / ASOS Backbone System And:			
Ajo Municipal	AWOS-3	Laughlin / Bullhead International	AWOS-3
Avi Suquilla	AWOS-3	Marble Canyon	AWOS-A
Bagdad	AWOS-3	Memorial Airfield	AWOS-A
Bisbee Municipal	AWOS-A	Mesa - Falcon Field	AWOS-3
Buckeye Municipal	AWOS-3	Payson	AWOS-3
Chinle	AWOS-3	Phoenix - Goodyear	AWOS-3
Cochise College	AWOS-3	Pinal Airpark	AWOS-A
Cochise County	AWOS-3	Polacca	AWOS-3
Coolidge Municipal	AWOS-A	Quartzsite (New)	AWOS-A
Cordes Lake (New)	AWOS-A	San Manuel	AWOS-A
Cottonwood Municipal	AWOS-3	Sells	AWOS-3
Douglas Municipal	AWOS-A	Show Low Municipal	AWOS-3
Eloy Municipal	AWOS-3	Springerville - Babbit Field	AWOS-3
Gila Bend Municipal	AWOS-3	Stellar Airpark	AWOS-A
Glendale Municipal	AWOS-A	Tempe Bar	AWOS-3
Globe - San Carlos Regional	AWOS-3	Tuba City	AWOS-3
Grand Canyon Caverns	AWOS-3	Tuweep	AWOS-3
Grand Canyon West	AWOS-A	Wickenburg Municipal	AWOS-3
Greenlee County	AWOS-A	Williams Gateway	AWOS-3
H.A. Clark Memorial Field	AWOS-3	Dateland (non - airport location)	AWOS-3
Kayenta	AWOS-3		

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See Appendix A for acronym definitions.

Source: QED.

Figure 7-5
FINAL AWOS REQUIREMENTS



Broadcast

An evaluation was made of the most appropriate means to broadcast the AWOS-generated report to pilots en route. Factors that entered into the analysis included the availability of navigational aids (NAVAID) on the airport with voice capability to broadcast the weather observation. A VHF discrete frequency transmitter (DFT) would be required in those instances where a suitable NAVAID was unavailable. The use of a localizer to broadcast the AWOS report is not recommended because the localizer signal is highly directional and would only benefit aircraft within its propagation characteristics. Another broadcast option involves the use of Unicom radio frequency. When the radio is unattended, the pilot can use a microphone keying sequence to acquire a synthesized voice broadcast of the weather observation. As an alternative, consideration could be given to permit the Unicom to broadcast the AWOS report at pre-selected time intervals using present dial-up technology.

The FAA is moving toward the eventual replacement of most ground-based NAVAIDS as they reach the end of their useful lives or otherwise become too expensive to maintain. The application of GPS technology is on-going and by the year 2005 - 2010 timeframe is envisioned to be a primary source for flight navigation. Consequently, it would be prudent to establish the broadcast means for the AWOS facilities utilizing DFT equipment.

The bandwidth assigned for aeronautical purposes, as managed by the FAA in coordination with the Federal Communications Commission (FCC), is limited and in certain geographical areas restricted. In those instances where the suggested ground-to-air broadcast means is not available, the alternatives listed below should be considered:

1. Joint use of a single frequency. For example, up to three AWOS reports can be broadcast sequentially via a single frequency. This will necessitate the use of a communications network to link the reporting facilities.
2. Dissemination via a communications network to the nearest AFSS/FSS that will provide the report to the pilot on an as-needed basis. However, this is a proliferation of the current procedure and not necessarily an appropriate solution.
3. Use of data-over-voice (DOV) or voice-in-data (VID) emission modes for batch weather products transmission to the aircraft.

Federal ASOS and AWOS installations may utilize an available automatic terminal information service (ATIS) frequency, voice capable NAVAID or VHF discrete frequency when the installation is at an airport with an air traffic control tower (ATCT). Controllers will relay the ASOS/AWOS report to the pilot as part of their normal air traffic control procedures. When the ATCT is unmanned, the ASOS/AWOS broadcast will be the official weather observation.

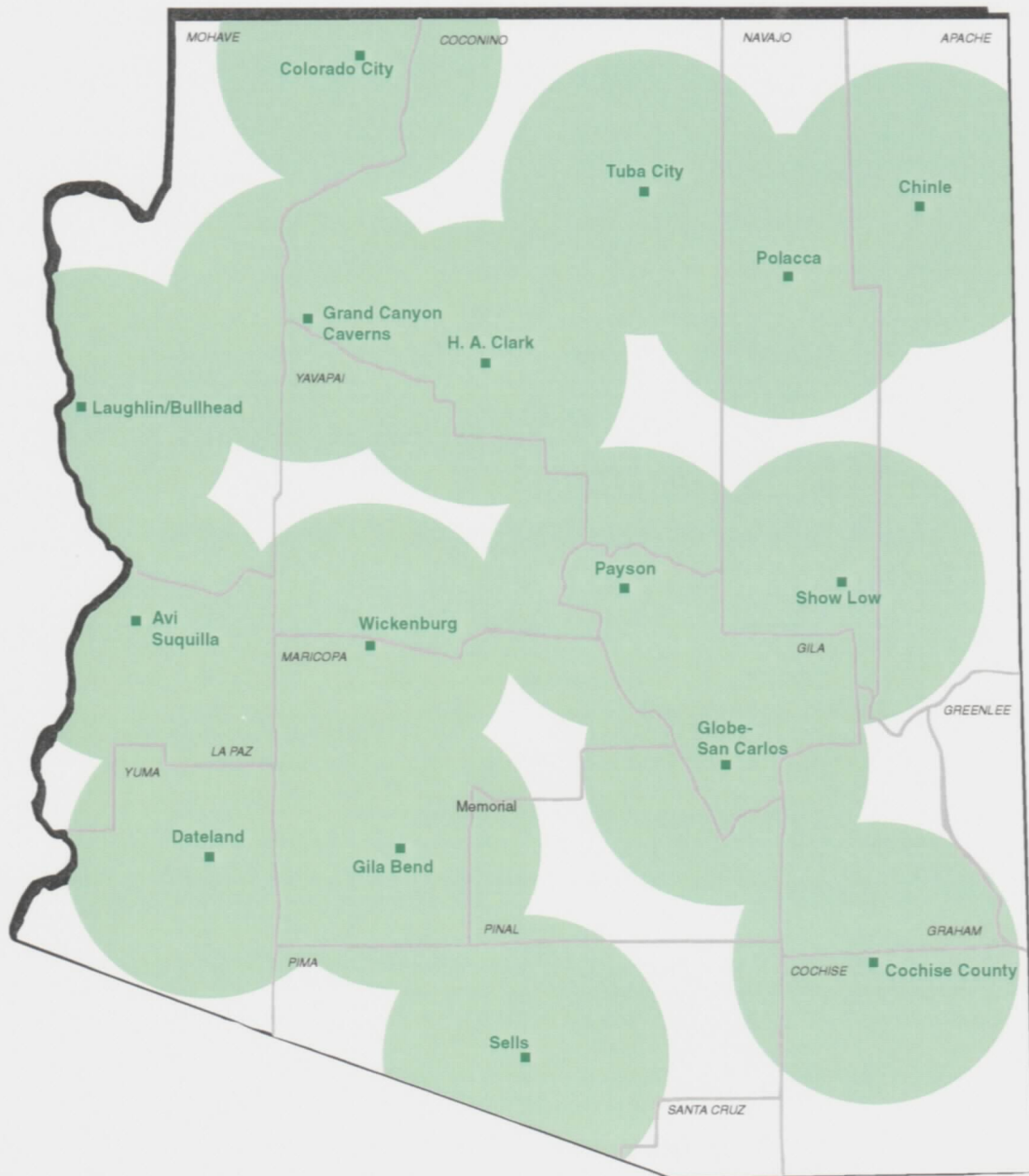
AWOS-3 Upgrades

An area of interest with respect to weather coverage and addressed earlier in this chapter concerns the upgrade of AWOS-3 units to an AWOS-4 capability. The AWOS-4 can provide additional real-time weather condition information to support the tracking of weather frontal movement. Coverage requirements can be based on a 30-knot frontal passage speed and a 90-minute travel time between AWOS-4 units, representing a distance of 45 nautical miles. Because the ability to enhance the tracking of weather movement is intended to support State objectives, the preferred course is to identify those non-federal AWOS-3 units that should be upgraded to an AWOS-4 capability. This isolates the AWOS-4 program from federal decisions and policies concerning the types of sensors in a federally-owned and operated ASOS/AWOS configuration or the means by which the data from these units may be obtained. The primary criterion to monitor weather movement is the strategic location of these units with the objective of providing effective statewide coverage.

On this basis, 16 of the AWOS-3 sites recommended in the preceding section should be upgraded to an AWOS-4 capability at such time as this AWOS type is certified by the FAA. The AWOS sites selected for upgrade are presented in Figure 7-6 and include:

Avi Suquilla	H.A. Clark Memorial
Chinle	Laughlin/Bullhead International
Cochise County	Payson
Colorado City Municipal	Polacca
Dateland (non-airport)	Sells
Gila Bend Municipal	Show Low Municipal
Globe-San Carlos Regional	Tuba City
Grand Canyon Caverns	Wickenburg Municipal

Figure 7-6
 AWOS-4 LOCATIONS
 (POTENTIAL UPGRADE)



LEGEND

- AWOS-3 unit to be upgraded to AWOS-4 capability
- Limit of coverage

